National Aeronautics and Space Administration

The Next Frontier of AI will be in Space

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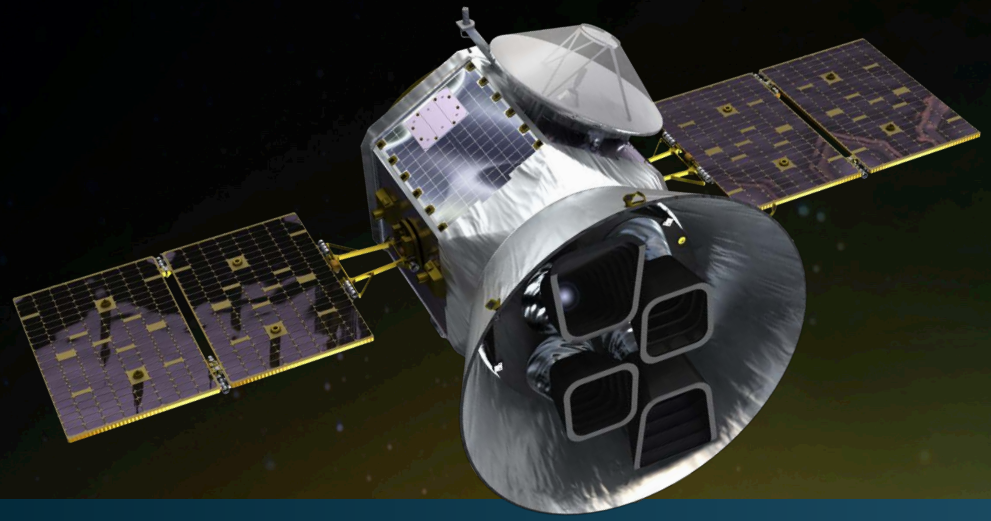
BIG DATA IN SPACE: "*TESS*" AND "*ASTROBEE*"



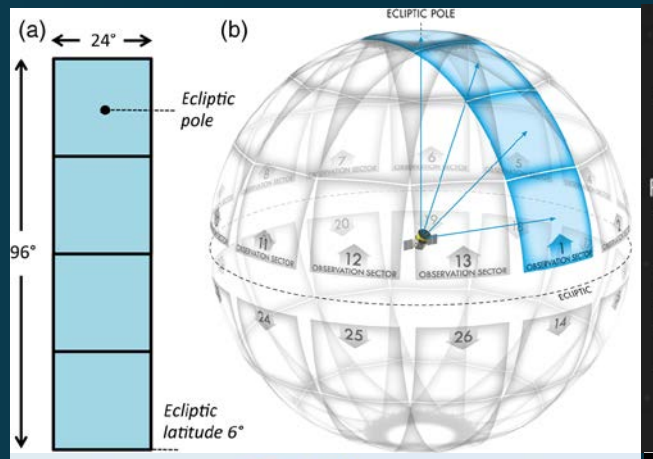
TRANSITING EXOPLANET SURVEY SATELLITE (TESS)

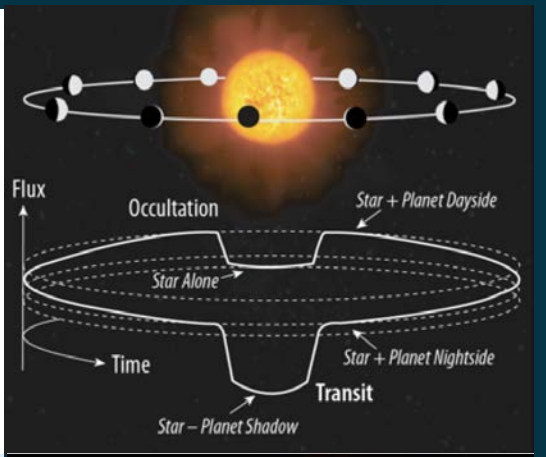
TESS: unlocking the secrets of exoplanets

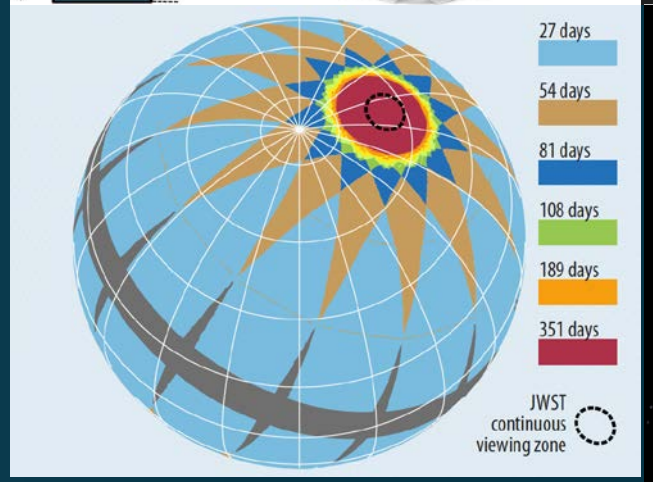
TESS Observations

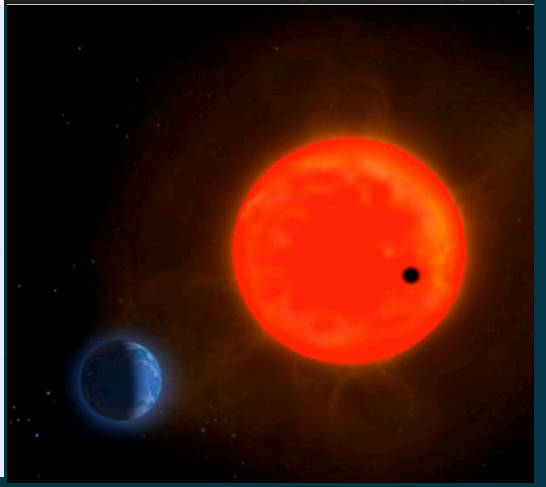
TESS will tile the sky with 26 observation sectors:

- Minimum of 27 days, staring at each 24° × 96° sector
- Brightest 200,000 stars at 2-minute cadence.
- 20,000,000 stars in full frames at 30 min cadence
- Sectors overlap at ecliptic poles for sensitivity to smaller and longer period planets in JWST Continuous Viewing Zone (CVZ)









TESS
Science Data Processing Pipeline

Ames Research Center

TPS

TESS and Kepler Data Rates

	Kepler	TESS	TESS/Kepler
# stars	165,000	15,000	0.09
samples per day	48	720	15.00
pixels per star	32	100	3.13
days FOV^{-1}	93	27.3	0.29
Mission Duration (years)	4	2	0.5
target star pixels day^{-1}	253,440,000	1,080,000,000	4.26
Background Target Pixels	378,000	0	0.00
Background Pixels day^{-1}	18,144,000	0	0.00
Collateral Pixels	280,056	3,908,864	13.96
Collateral Pixels day^{-1}	13,442,688	2,814,382,080	209.36
All Science Pixels day^{-1}	285,026,688	3,894,382,080	13.66
All Science Data GiB day^{-1}	1.06	14.51	13.66
All Science Data GiB observing window^{-1})	0.10	0.39	4.01
All Science Data GiB mission^{-1}	1.51	10.34	6.83
FFI pixels	97,370,112	71,017,728	0.73
FFI samples day^{-1}	0.03	48.00	1,488
FFI pixels day^{-1}	3,140,971	3,408,850,944	1,085.29
FFI GiB day^{-1}	0.01	12.70	1,085.29
Science+FFI GiB day^{-1}	1.07	27.21	25.34
Science+FFI GiB FOV^{-1}	99.84	743.33	7.45
Science+FFI GiB mission^{-1}	1,567	19,861	12.67

AI and NASA Data Used to Discover 8th Planet Circling Distant Star

Google AI, came up with the idea to apply a neural network to Kepler data. He became interested in exoplanet discovery after learning that astronomy, like other branches of science, is rapidly being inundated with data as the technology for data collection from space advances.

Ref: https://www.nasa.gov/press-release/artificial-intelligence-nasa-data-used-to-discover-eighth-planet-circling-distant-star

How to interact with TESS data!

https://archive.stsci.edu/tess/ or google "TESS data MAST". First result.

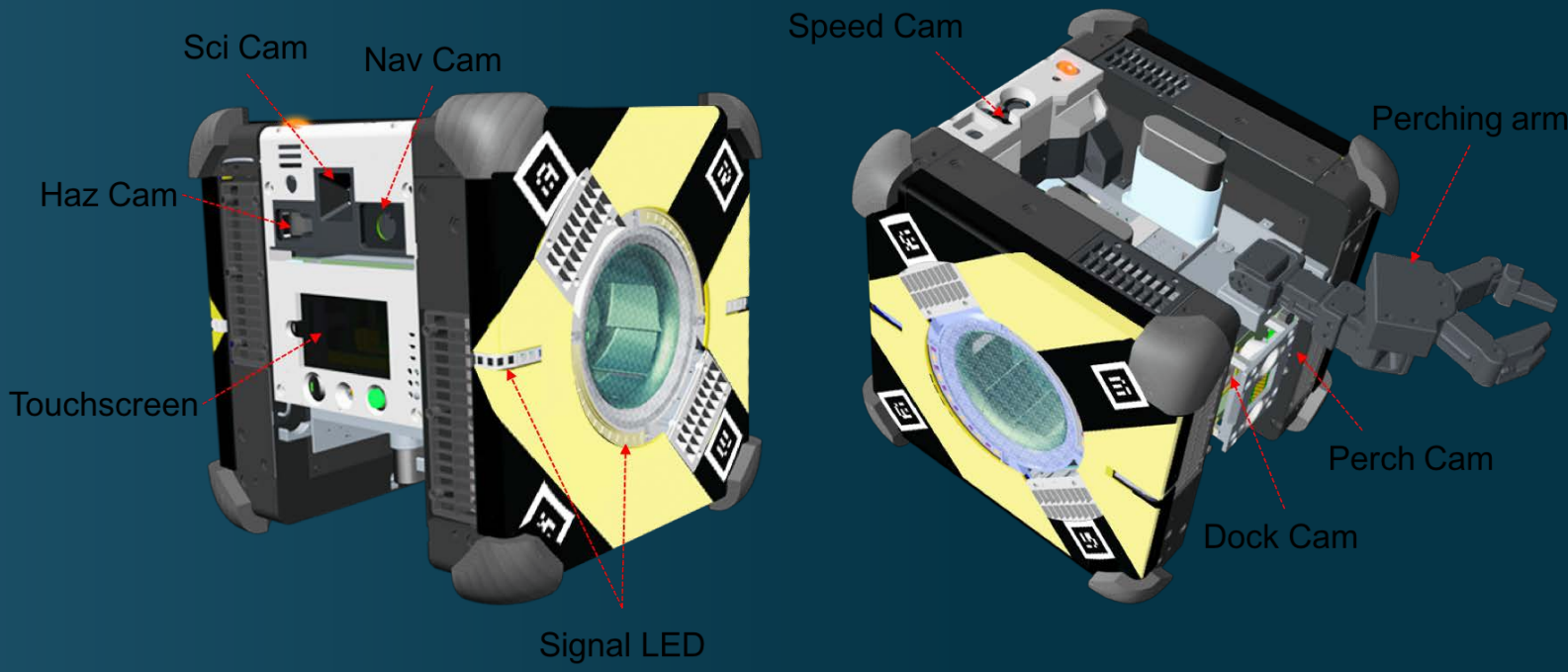
- Download light curves, target pixel, and data validation files for a few targets.
- Python notebooks that show how to open and use TESS data products, search for target information at MAST, and retrieve data products after a search.
- Access all the TESS sectors 1 & 2 data directly in the AWS cloud.

ASTROBEE Free-flying robots

Astrobee on the ISS

Astrobee Objectives

1. Provide a microgravity robotic research facility in the ISS, which will replace the existing SPHERES facility
2. Provide remotely operated mobile camera views of the ISS to enhance the situation awareness of mission control
3. Perform mobile sensor tasks in the ISS



Astrobee Data processing

Astrobee's localization

Mapping

Path planning

Name	Rate (Hz)	Value
Sparse Map	—	BRISK descriptors and positions
AR Tag Map	—	AR tag IDs and corner positions
IMU Acceleration	62.5	Linear acceleration a_{imu}
IMU Angular Vel.	62.5	Angular velocity ω_{imu}
Sparse Map Features	≈ 2	Coordinates in image and map
AR Tag Features	≈ 5	Coordinates in image and map
Handrail Features	≈ 5	Depth image and global positions
Optical Flow	≈ 5	Multiple image coordinates

TABLE I

INPUTS TO ASTROBEE LOCALIZATION.

1 Gbit/min total data (localization + hazcam, etc..).

Have 2 Bit/sec DL data rate from the ISS. We save the data that Guest Scientists need/want

How to get involved with Astrobee!

The Astrobee Robot Software has been released as an open source project under an Apache 2 license. Not only does this enable guest scientists to develop experiments for Astrobee, but members of the public to obtain, test and potentially contribute back to the project.

https://github.com/nasa/astrobee

This repository provides flight software and a simulator, both primarily written in C++. The repository also provides several other utilities, including a tool for creating maps for localization.

Thanks very much for the attention!

Any questions?